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Impact characterization of epoxy LY556/ricinus communis L plant natural fiber composite materials

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Abstract

The Climate change is the main issue for world for living all creatures, because of climate change global warming will happen. The reasons behind global warming are like carbon, carbon dioxide products, and non - environmental products etc. Global warming may stop by promoting non-carbon products like natural products, solar energy; wind energy etc. Natural fibers composites are useful to replace the carbon, synthetic products. From last few decades many researchers had done research on natural fiber composites. In the present investigation composite of Epoxy/ castor oil plant cortex fiber (*Ricinus Communis L*) were prepared by hand layup technique. Composites with 0.10, 0.20, 0.30, 0.40 volume fractions of charpy impact specimens were prepared as per ASTM D256. The impact strength (KJ/m²) of castor oil cortex fiber composite is 5.2 times to that pure epoxy matrix.

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Keywords: Castor oil plant; Natural fiber; Composites; impact strength

1. Introduction

Ricinus Communis L often called castor oil plant comes under the category of “cool tropical plants” since it is found in tropical parts of Asia, Africa and mostly Australia and also the seeds are spurted out during winter or cool prevailing conditions [1]. The leaves though do not contain much toxicity than the seeds are placed alternatively on the stem on long and purple foot stalks with blades drooping about 5-8 inches. When younger the leaves would shine with attractive red in colour and after full growth, when expanded completely would be in blue-green colour. Coming to the flowers the male and the female flowers grow on the same plant and are present in a clustered terminus spike. To the bottom of this spike the male flowers are present which do not have corolla but a calyx with yellow stamens. The upper part of spike is occupied by female flowers with no corolla either but with narrow segments of calyx. These flowers have no petals since pollination in the plant is air borne that is pollination occurs due to wind.

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But the most important part of the plant is fruits which yield castor seeds. Fruits are generally bluntly grooved in greenish colour with prickles in which seeds are present. These seeds are actively poisonous for livestock including humans [2]. The seeds are so poisonous that consumption of only 4 to 8 seeds would tend to become fatal for humans and without proper medical treatment death occurs in 4-5 days. The symptoms tend to occur within few hours of ingestion with burning sensation, diarrhoea, and nausea reduced hydrated fluids in body, low blood pressure and reduced excretion

K.Ramanaiah et al. [3], done work on waste grass broom fibre is reinforced in polyester resin; they evaluated the mechanical and thermal properties of that composite. In that work volume fraction of fiber in composite greatly influence the IZOD impact strength. The impact strength of composite with 0.358 volume fraction was got 296 J/m.

Nadendla Srinivasubabu et al, [4], worked on characterization and manufacturing of long Palmyra palm/borassus flabellifer petiole fiber composite. They did tensile, flexural, impact ,dielectric specimens as, per ASTM. The highest impact strength for volume fraction of 40.94% was found 56.73 KJ/m².

Nadendla Srinivasubabu et al, [5], did NAOH treatment to broom grass fiber and made composites, They achieved more tensile strength, modulus , flexural strength ,modulus ,and impact strength for composites after treatment.

In this present work on composite of Epoxy/ castor oil plant cortex fiber (*Ricinus Communis L*) were prepared by hand layup technique. Also made composites with 0.10, 0.20, 0.30, 0.40 volume fractions of charpy impact specimens as per ASTM D256 by new fiber of castor oil plant fiber (*Ricinus Communis L*). The impact strength (KJ/m²) of Castrol oil cortex fiber (*Ricinus Communis L*) composite is 5.2 times to that pure epoxy matrix and the impact strength (J/m) of castor oil cortex fiber (*Ricinus Communis L*) composite are 5.8 times to pure epoxy. *Ricinus Communis L* fibre showed very good impact results so it may use in different applications like decks, windows frames, seat bottoms ,automobile applications.

Previously the purpose of castor oil plant is used for castor oil which is getting by castor seed. After using the castor seed, remaining parts of plant is throwing as waste. But, in this work, authors made new composite material which is low cost and lightweight materials.

2. Experimental Procedures

2.1. Material

The materials which are used in the present investigation are matrix, hardener and fiber. LY 556 epoxy resin and HY951 hardener are purchased from local dealers in Hyderabad, India. The properties of resin and hardener are mentioned Table 1 and Table 2. The resin – harder mixture decides the bond strength between fiber and matrix. Good mixing ratio of resin and hardener is 10:1 for better strength is considered in the present research work [6]. Properties of epoxy and hardener are low viscosity system and excellent water resistance and glass fiber laminates are dimensionally stable. Applications are in industrial and structural and automobile composites.

Table 1: Key properties and specific key data of Araldite LY556 and Aradur HY 951. These values are provided by HUNTSMAN.

Property	Specification	Unit	Araldite LY556	Aradur HY 951
Viscosity at 25°C	ISO 12058	mPa.s	10000-12000	10-20
Density at 25°C	ISO 1675	gm/cc	1.15-1.20	0.97-0.99
Flash point	ISO 2719	°C	>200	>180

Table 2: Processing of mixing ratio of Araldite LY556 and Aradur HY 951. These values are provided by HUNTSMAN

Name	Parts by weight
Araldite LY556	100
Aradur HY 951	10-12



Fig.1 Castor oil cortex fiber

2.2. Preparation of fiber

In the present investigation Castor oil cortex fibers (Fig.1.) are obtained by retting and mechanical rolling. Then those fibers dried under sunlight for two days. Composites with four volume fractions 10, 20, 30 and 40% are prepared by using hand layup process which is explained in the subsequent sections of this part. These specimens for charpy impact test are as per ASTM D256.

2.3. Fabrication procedure

In this work manual hand layup method is used for preparing charpy impact specimens. Releasing agent applied to bottom and top of the mold to take out the specimen easily. Calculated amount of resin is poured directly into bottom mold then castor oil cortex fiber fibers are placed in unidirectionally. After the settlement of fibers in epoxy then top plate of the mold put on the bottom plate with hand and apply pressure for a few minutes. Curing time is considered for 24 h [7].

Here, authors made four different volume fractions of composites. Those are 0.1Vf, 0.2Vf, 0.3Vf, 0.4Vf and 100% epoxy specimen. Charpy impact specimens are prepared by castor oil plant fiber which is shown in Fig.2 and Fig.3 representing the specimens.

2.4. Impact testing of composite

Charpy impact testing of composite done by ASTM D256 [8]. Specimen's dimensions are 127 mm long , 12.7 mm width , 10 mm thickness and a sharp file with include angle of 45 degrees was drawn across the center of the saw cut at 90 degrees to the sample axis to obtain a consistent starter crack. It can be observed in Fig.3. Charpy impact tests were conducted at CIPET Hyderabad. That machine (Fig.4) specifications are Range 0.5-15 joule, Accuracy 0.01J, make by TIMES OLSEN. Notch cutter also can be observed in Fig.5.

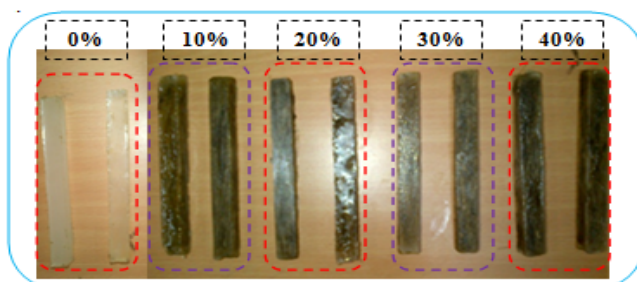


Fig 2: Composites with different volume fractions of fiber



Fig 3: Starter crack can be seen in Composite



Fig 4: IZOD/CHARPY Tester



Fig 5: Notch cutter

3. Results and Discussion

3.1. Impact strength of composite

It is obvious that the increase in fiber content, the impact energy (J), the impact strength (KJ/m²) and impact strength (J/m) are increases which are presented in Table 3. The energy absorbed by composite in testing is equal to the loss of energy during impact. Those values can be observed. It is evidence that 0.4 Vf composite absorb more energy than 0.3 Vf composites, 0.2 Vf composite, 0.1 Vf composite and 100 % epoxy. The 0.4 Vf composite got high impact strength due to proper arrangement of fibers and more percentage of fibers than other volume fractions composites (0.1Vf, 0.2Vf, 0.3Vf). Because of this reason, crack propagation will difficult than other volume fractions of composites. The impact strength of the Castor oil cortex fiber composites is increasing with 0-40 % fiber volume fraction [9]. The highest impact strength of 6.99511 KJ/m² and 87.9985 J/m is found at 0.4 Vf composite.

Table-3 Impact energy values of Castor oil cortex fiber composites As per ASTM D256.

Fiber Volume Fraction (%)	Width (mm)	Depth (mm)	Energy (J)	Impact Strength (KJ/m ²)	Impact Strength (J/m)
0%	10	12.7	0.1570	1.325	15.17
10%	10	12.7	0.5777	4.6423	50.3234
20%	10	12.7	0.6231	4.6186	56.3470
30%	10	12.7	0.7843	5.5512	71.0657
40%	10	12.7	0.9803	6.9951	87.9985

4. Conclusions

This work represents the fabrication of partially biodegradable composite of charpy impact specimen with various volume fractions as per ASTM D256 by new fiber of castor oil cortex fiber. The 0.4 Vf composite shows good ability to absorb impact force than other volume fractions of composites. The impact strength (KJ/m²) of Castrol oil cortex fiber (*Ricinus Communis L*) composite is 5.2 times to that pure epoxy matrix and the impact strength (J/m) of castor oil cortex fiber (*Ricinus Communis L*) composite are 5.8 times to pure epoxy matrix. Hence, the newly developed castor oil cortex fiber composite material can be used in house interior parts, and cupboards and car interior part and sports applications.

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